Mississippi. It is admirably adapted to the needs of teachers and could well be made the basis of a practical and interesting first course in geology.

Mississippi is particularly fortunate in the publication of a report such as Mr. Lowe has prepared. It deserves a wide circulation among the people of that state.

H. R. B.

Geology and Ore Deposits of the Philipsburg Quadrangle, Montana. By. W. H. EMMONS and F. C. CALKINS. U.S. Geol. Survey, Prof. Paper 78, 1915. Pp. 271, pls. 17, figs. 55.

The Philipsburg quadrangle includes an area of 827 square miles lying immediately west and northwest of Anaconda, Montana. It is a country of strong relief, almost midway between the eastern and western divisions of the Rocky Mountains. The geologic section includes formations ranging in age from Algonkian to Recent. The Belt series, the oldest rocks in the area, is divided on lithologic grounds into six formations. Their total thickness is 15,000 feet. Next above and separated from the Belt series by a striking unconformity is the Cambrian system, comprising the Flathead, Silver Hill, Hasmark, and Red Lion formations. The Red Lion contains Upper Cambrian fossils. It is overlain by the Maywood formation, of doubtful Silurian age. The Devonian is represented only by the Jefferson limestone; the Mississippian by the Madison limestone; the Pennsylvanian by the Quadrant formation. Though the stratigraphic relations of the Paleozoic systems was not clearly made out, each is probably set off by disconformities.

The Mesozoic is not strongly developed in this part of Montana. Only three formations are here present—the Ellis, Kootenai, and Colorado. The early Tertiary was marked by powerful crustal movements. The pre-Tertiary sediments were complexly folded and overthrust and extensive igneous masses were intruded. Later the region was the scene of two epochs of vulcanism. Certain gravel deposits contain Miocene vertebrates. The Tertiary closed with tilting and a general uplift. During Pleistocene time there were at least two stages of Alpine glaciation.

The early Tertiary batholiths and smaller intrusives are granites, granodiorites, and diorites, with associated pegmatites, aplites, and lamprophyres. At and near their contacts with these intrusives the sediments are notably altered. The pneumatolytic solutions that effected these changes are believed to have carried chlorine, fluorine,

boron, iron, soda, and silica. Recrystallization cannot be relied upon as the sole explanation of the observed development of silicates and other contact minerals; they are due in part to a transfer from magmatic sources. The ores of the district are genetically related to the intrusives, their deposition representing the closing stage of igneous activity.

The first discovery of placer gold in Montana was made within the Philipsburg quadrangle in 1852. The gravels have yielded something less than $2,000,000. The total production of the underground mines, developed later, is about $50,000,000. Of this amount one-fifth is gold, the remainder silver. The deposits are of three types: fissure veins cutting both igneous and sedimentary rocks, contact metamorphic replacement deposits in limestone near the granite intrusives, and replacement deposits in sedimentary rocks.

Silver-bearing veins in granite are of principal importance, the Granite-Bimetallic mines having yielded $32,000,000. The veins follow strong, sharply defined fissures. The wall rock shows strong hydrothermal alteration of the sericite-calcite type. The primary ore has a gangue of quartz, calcite, and rhodochrosite inclosing sulphides—pyrite, stibnite, tetrahedrite, tennantite, galena, arsenopyrite, and sphalerite. Later the veins were fractured and refilled with calcite and rhodochrosite. Secondary sulphides, chiefly pyrargyrite, are conspicuously developed between the 300- and 800-foot levels. Oxidized ores containing cerargyrite, pyromorphite, and native silver occur above this zone.

At the Cable mine a contact metamorphic gold copper ore occurs in a tabular mass of limestone surrounded by granodiorite. The ore replaces limestone and consists of coarse calcite and quartz with pyrite, pyrrhotite, arsenopyrite, magnetite, and gold. The typical ore is not an intergrowth with heavy contact silicates. Those minerals formed before the principal ore deposition began.

Gold-bearing replacement veins in limestones near intrusive contacts form a transitional type. The minerals of the ore are quartz, calcite, siderite, and some pyrrhotite, magnetite, and specularite. Pyrite is the principal auriferous mineral.

This report deserves a high place among recent economic papers.

H. R. B.